FH AACHEN
UNIVERSITY OF APPLIED SCIENCES

Technical Standard for Pilot´s Watches TeStaF

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The **Technical Standard for Pilot's Watches**
is available in both a German and an English version.
In case of doubt, solely the German version is authoritative.

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Foreword

Many individuals have contributed to the „Technical Standard for Pilot‘s Watches“ project by offering expert advice and providing active assistance on key aspects. The authors would like to thank all of them.

Principal among these are Volker Bau (Eurocopter Deutschland GmbH, Donauwörth), Wilfried Delle (W. Ludolph GmbH & Co. KG, Bremerhaven), Ralf Geiss (ADAC Luftfahrt Technik GmbH, Bonn-Hangelar), Werner Gelhausen (Simulatorzentrum ADAC HEMS Academy GmbH, Bonn-Hangelar), Stephan Günther (ADAC Luftfahrt Technik GmbH, Bonn-Hangelar), Ulrich Jarolimek (ISP-Aachen Ingenieurgesellschaft für Sensortechnik und Prozessautomation mbH), Walter Kampsmann (Westflug Aachen Luftfahrt GmbH & Co. KG), Col. Colin Miller, M.D. (United States Army, retired), Stefan Prade (ADAC Luftrettungszentrum Aachen), Steffen Schrader (Fachhochschule Osnabrück), Dr. Bernhard Walfort (RC Tritec AG, Teufen, Switzerland).

Furthermore we would like to express our gratitude to the faculty and staff of the Aachen University of Applied Sciences and the employees of Sinn Spezialuhren GmbH for their active involvement in, and to the employees of Eurocopter Deutschland GmbH for their help and support throughout the project.

Special mention should also be made of the many pilots who showed their support by taking part in the „Critical Flight Timing Requirements“ survey which formed an integral part of the project. The results of this survey provided important feedback for the Technical Standard for Pilot‘s Watches by incorporating the authentic experience of the professional users of pilot‘s watches.

1 | Introduction

The history of aviation is closely linked to the history of measuring time. Indeed, a special type of watch, the pilot‘s watch, was created for this very purpose. Wristwatches incorporating special functions and features were the principal timekeepers during the rapid development of flight in the 20th century. Today they are still the primary instrument of time measurement in some prototypes, and in aerobatic and historical aeroplanes, and they continue to serve as back-up systems in other aircraft even in the days of satellite-based time measurement.

However, the original term „pilot‘s watch“ as characterised by explicit functional and physical specifications has since become more loosely defined. It now encompasses conventional wrist-watches with a clear design as well as technically superior watches with typical aviation-related features such as a low-pressure resistant crystal mounting. There is no accepted definition for pilot‘s watches comparable to that for diver‘s watches (DIN 8306 / ISO 6425).

The Flight Laboratory of the Faculty of Aerospace Technology of the Aachen University of Applied Sciences and Sinn Spezialuhren GmbH in Frankfurt am Main have produced a standard which defines the requirements which mechanical pilot‘s watches with analogue display must fulfil for civilian flights operating under visual and instrument flight rules, respectively. The standard is supported theoretically by systematic analysis of the relevant aviation regulations and empirically by e.g. application-oriented experiments as well as a detailed survey of pilots of different categories of aircraft[1]. And finally, the results of the project were reviewed and validated in a detailed field-test.

A wristwatch which meets this „Technical Standard for Pilot‘s Watches“ offers the assurance that it fulfils the relevant functional and physical requirements for time measurement devices in the different aircraft categories.

1 „Critical Flight Timing Requirements Survey“, a qualitative survey based on questionnaires and follow-up questions carried out by Martin Hoch from April to August 2008. Participants were over 20 pilots of different aircraft categories (including all significant aircraft categories such as CS-22, CS-23, CS-25, CS-27 and CS-29), representing more than 30 different types of aircraft.

2 | Definition of „pilot´s watch“

In the event of simultaneous failure of the aircraft‘s timing instruments, or even a suspected failure, it is the purpose of the pilot‘s watch, as the primary time measurement instrument, to enable the pilot to plan and execute any necessary time-related flight manoeuvres, thereby providing a comprehensive substitute for the timing instruments installed or mandated in the aircraft.[2]

The functioning of a pilot‘s watch shall not be affected by the physical stress of regular flying or by unexpected malfunctions of the aircraft. In all conditions its operation shall be simple and reliable and it shall be easily readable. It shall not present a potential risk for crew members, other instruments or the aircraft itself.

2 EU-OPS (=JAR-OPS 1) 1.630 c (3) as per EU-OPS (=JAR-OPS 1) 1.650 (b) and 1.652 (b); JAR-OPS 3.630 c (2) as per JAR-OPS 3.650 (b) and 3.652(b); CS-23 Book 2, Appendix 6, CS-25.1303, CS-29.1303; 3. DV LuftBO § 2 (1) 2 letter j and ibid. § 5 (1) 4; FAR 25.1303, 29.1303, 91.205 and 121.305.

3 | Requirements

3.1 | Functionality

3.1.1 | Functional elements

Minimum requirements for flights operating under visual (VFR) or instrument flight rules (IFR):

Minimum requirements	VFR	IFR
Wristwatch with 12 or 24 hour display, plus minutes display	✓	✓
Central second hand[3]	✓	
Stopwatch function measuring at least 30 minutes[4]		✓
Central stopwatch seconds display		✓
Permanent second hand for function check[5]		✓
Bezel rotatable in both directions, with at least one marker for measuring time[6]	✓	✓
Precision time-setting function (hacking mechanism)	✓	✓

3 The necessity of the central second display derives from CS-25.1303 and CS-29.1303 and also from FAR 25.1303, 29.1303, 91.205 and 121.305. The second display is also stipulated in EU-OPS and JAR-OPS cited in footnote 3 and in the 3rd LuftBO § 5 (1) 4.
4 Esser p. 17.
5 Esser p. 17.
6 Esser p. 17.

3.1.2 | Readability in daylight

(a) The time display, rotatable bezel and stopwatch function (if incorporated) must permit rapid and unambiguous readability to the second or minute.

(b) Daytime visibility colours include black, white and additional colours with the exception of red.[7]

(c) The contrast between the dial markings and the background, the hands and the dial background, and the rotatable bezel markings and the bezel ring itself must be as stark as possible. The brightness ratio between the markings and the background must be at least 14:1 under standard conditions.[8] This must be measured with the watch in its fully functioning state, i.e. including the watch crystal.

3.1.3 | Readability at night

(a) Taking section 3.1.3 (b) and section 3.3.3 into account and without manual activation of controls, it must be possible to read the time display and stopwatch function (if incorporated) in the dark to an accuracy of at least five minutes or five seconds.

(b) Taking section 3.1.2 (c) into account, the watch must contain luminous markings for the following elements (inverse application of luminous paint is possible):

7 CS 22.1322, CS 23.1322, CS 25.1322, CS 27.1322, CS 29.1322, CS-VLA.1322 and CS-VLR.1322 assign a special and clearly defined warning function to the colour red in aviation.

8 Standard conditions include: at least 30 % of the surface of the tip of the centrally positioned hands being tested, and the entire surface of the tips of non-central chronograph („small“) hands must have a minimum contrast of 14:1 to the swept background. The part of the dial surface which is not covered by contrasting printed scales and/or figures constitutes the background to the hands; if non-central auxiliary chronograph dials are colour-contrasted to the main dial, the background with the lower contrast is to be used for the contrast measurement of the central hand.

Luminous markings	VFR	IFR
All hour indices	✓	✓
The hour and minute hands	✓	✓
Central second hand	✓	
The 5-minute markings of the stopwatch minute indices		
(unless identical with the hour indices)		✓
The stopwatch minute and second hands		✓
At least one marker on the rotating bezel	✓	✓

(c) Red must not be used as a luminous colour.[9]

(d) It must be possible to clearly orientate the dial in the dark on the basis of suitably shaped luminous elements.

(e) In compliance with the requirements stipulated in NIHS 97-21 / ISO 17514 section 4.2.2, the elements named in 3.1.3 (b) must remain readable for three hours in complete darkness after being fully charged.[10] This shall be tested using the complete watch, i.e. including the watch crystal.

3.1.4 | Operability

(a) The rotatable bezel must feature clearly perceptible minute ratcheting to provide tactile feedback to the user. The operating elements of the stop-watch function (if incorporated) must have a clearly discernible point of resistance.[11]

(b) The controls must function across the entire temperature range specified in section 3.2.2 (a).

(c) It must be possible to operate the controls accurately even when wearing common aviation gloves.

9 See note 7.

10 Using state-of-the-art luminous paints.

11 Esser p. 21.

3.1.5 | Accuracy

(a) The accuracy test shall be carried out at the following temperatures with the stopwatch function (if incorporated) turned off: -15° C, +23° C and +55° C. If other extreme values of the operative temperature range are used as stipulated in section 3.2.2 (a), these replace the tests at -15° C and +55° C.

(b) The test shall be conducted in the following four positions: 6 o'clock up-wards, 9 o'clock upwards, dial upwards, case back upwards.

(c) The test is to be carried out with the watch fully wound.

(d) In all accuracy tests, the rate values in the individual test positions must not exceed +/- 30 seconds per day at all test temperatures.[12] At +23° C the permissible range is 15 seconds per day.[13] The requirements in section 3.2.4 are independent of the values indicated here.

3.1.6 | Power reserve

After being fully wound, the watch must have sufficient power to run for at least 36 hours without the mainspring being rewound.[14] If a stopwatch function is incorporated, the first three hours of the measurement must be carried out with the stopwatch function activated.

12 Setting the time once per day, the watches must be accurate to within one minute; see Esser pp. 21–22.
13 The range is the absolute value of the greatest difference between the mean rate and one of the rates in the test positions. The terms and threshold values are derived from the chronometer standard DIN 8319 / ISO 3519.
14 MIL-PRF-46374G section 3.4.2.1.1. The measurements are based on a stipulated running time of at least 24 hours and a safety margin of 50%.

3.2 | Resistance to external stress

All the requirements given in section 3.2 must be fulfilled without the functioning being impaired, and without any external damage to or loss of fixed or moving parts of the watch or the crystal. The accuracy requirements defined in section 3.1.5 (at +23° C) must be met, and the mass flow must be tested as stipulated in DIN 8310, section 6.4.1, unless otherwise specified. This must be checked after each test in section 3.2, with the exception of 3.2.2, 3.2.4, 3.2.8 and 3.2.9.

3.2.1 | Ambient pressure

(a) Assuming an internal pressure of 1.013 bar inside the case, the watch must be able to withstand a reduction in the ambient pressure from 0.752 to 0.044 bar (representing a differential pressure of 0.708 bar) within 15 seconds.[15] The external pressure of 0.044 bar must then be maintained un-interruptedly for at least two hours.[16] The test must be repeated after an interval of one hour. After each test a visual inspection shall be made of the watch, especially with regard to any change in the fit of the crystal. A water resistance test as defined in section 3.2.7 must be conducted after the second test.

(b) The watch shall be subjected to a pressure difference of 0.261 bar at least 2000 times to simulate a change cycle of the ambient pressure from 1.013 bar to 0.752 bar and back to 1.013 bar.[17]

15 ED-14F section 4, categories A1 to A4, test as per section 4.6.2; see Esser pp. 36–38.
16 ED-14F section 4, category E1, test as per section 4.6.1; see Esser pp. 36–38
17 Esser pp. 38–39.

3.2.2 | Operative temperature range

(a) The manufacturer must state the operative temperature range within which the watch must not exceed the maximum accuracy deviation as defined in section 3.1.5 (see section 4.1).[18]

(b) This temperature range must encompass at least the range from -15° C to +55° C.[19]

3.2.3 | Temperature change

The watch must be subjected to ambient temperature changes between the two extremes of the operative temperature range as stipulated in section 3.2.2 (a) within a period of 5 minutes.[20] The temperature change must be performed in both directions.

3.2.4 | Shock and impact resistance

Test according to DIN 8308 / ISO 1413.

3.2.5 | G-forces

The watch must be able to withstand 6 g of acceleration in each of the positions described in section 3.1.5 (b) for a period of one minute each.[21]

3.2.6 | Vibration

The watch must withstand a test subjecting it to uniformly varying frequencies between 2 Hz and 10 Hz and between 30 Hz and 60 Hz and an amplitude of 0.762 ± 0.127 mm as per Mil-PRF-46374G, table 1 and sections 3.5.1 and 4.6.5.9.[22]

18 Esser pp. 66–67.
19 Minimum values as per ED-14F, section 5, table 4-1.
20 ED-14F, section 5, category S2; see Esser p. 70.
21 CS 23.337; Esser pp. 40–43.
22 MIL-PRF-46374G table 1 and sections 3.5.1 and 4.6.5.9, plus the common oscillation frequencies of mechanical watch movements (2.5 Hz to 5 Hz). Due to the large number of potential sources of vibration-related stress in aircraft (determined e.g. by the type and model of aircraft and engine, its current condition, the actual flying conditions and engine power settings, the position and seat of the pilot and the manner in which the watch is worn), it is not possible to specify further binding requirements which apply to all categories of aircraft. Further research would be useful here.

3.2.7 | Water resistance

Based on DIN 8310 / ISO 2281, in compliance with section 6.4.2 table 1, excluding table 2. The test implementation is described in sections 6.4.3 and 6.4.5.[23]

3.2.8 | Resistance to common aviation fluids

The case, crystal and sealing materials must not be damaged by occasional and brief contact with common aviation fluids (see table below) at an ambient temperature of +23° C:[24]

Fuel	Kerosene (jet A-1)
	Gasoline/petrol (AvGas)
	Diesel
Lubricants	Petroleum-based
	Ester-based (synthetic)
Solvents and cleaning agents	Isopropyl alcohol
	Denaturated ethanol
De-icing fluids	Ethylene glycol
	Propylene glycol

The test can be performed on individual parts.

3.2.9 | Magnetic fields

Test according to DIN 8309 / ISO 764.[25] Section 3.1.5 of TeStaF is not applicable. The test can be replaced by a declaration of conformity or technical documentation issued by the manufacturer or a supplier. The declaration or documentation shall remain with the testing institute and its use is to be noted on the certificate.

23 See Esser pp. 39–40; ISO 22810 has now replaced ISO 2281. The authors are aware that the applicability of condensation tests as required by ISO 22810 and DIN 8310 is questionable due e.g. to the lack of comparability and that, accordingly, this requirement is in need of improvement.
24 See Esser pp. 61–64.
25 See Esser pp. 23–27.

3.3 | Safety and compatibility

3.3.1 | Magnetic signature
A watch which has just been demagnetised using a standard horological de-magnetiser must not influence a standard magnetic compass (approved for use in aircraft) positioned in its immediate vicinity (10 mm) by more than 2.5°.[26] [27]

3.3.2 | Light reflections
To avoid dazzling crew members and to ensure that the watch remains readable, the watch, when worn, must:be:

(a) Largely free of light reflected from the watch crystal by means of a state-of-the-art anti-reflective coating.

(b) Largely free of light reflected from the case, the controls, the dial, the hands, the indices, the strap and the clasp/buckle through appropriate finishing or design of the surfaces.

26 Based on ED-14F section 15, category Y; see Esser pp. 27–31. The permissible deviation of 1° (ED-14F) has been adjusted to 2.5° in order to accommodate the maximum reading accuracy of commonly available aircraft compasses; the minimum distance was increased from 0 mm to 10 mm, as a compass is not generally read while it is in direct contact with a watch.

27 The watch is measured in the “dial up” position with 3, 6, 9 and 12 o'clock relative to a given position of the compass, and rotated in each position by 45°, and, if required, at the crown (unless this is identical with one of the above positions) and above the center of the watch crystal. The watch is measured at three positions of the compass (see Esser p. 30); the distance between the watch and compass cases at this point is 10 mm. In addition, the watchstrap (including the clasp/buckle) with the outside facing the compass must be moved through the same measurement point relative to the compass and the effect on the compass measured at intervals of 15 mm starting from the middle of the clasp/buckle in both directions of the watchstrap. In none of the measured values of the watch or the watchstrap the deflection of the compass may exceed 2.5°.

3.3.3 | Compatibility with cockpit lighting
The readability of other instruments in the cockpit must not be compromised by the luminous effect of the watch as specified in section 3.1.3.

3.3.4 | Form
The form of the case and the controls must include as few protruding parts as possible in order to avoid the watch catching in the user‘s apparel or gear. This also serves to prevent catching in or blocking of moving or fixed parts of the aircraft.

3.3.5 | Strap fastening
In compliance with DIN 8306 / ISO 6425, section 7.5.1, the watch strap system must be able to withstand a tensile force of at least 200 N without any damage.[28]

28 The watch must be securely fastened to the wrist to prevent its loss during flight and subsequent injuries to persons or blocking of controls.

4 | Supplementary provisions

4.1 | Tests and certificate

(a) The Aachen Institute of Applied Sciences (AcIAS) e.V. issues type test certificates (see section 5 for sample) documenting that all the requirements stipulated in sections 3.1 to 3.3 have been fulfilled. Each certificate is issued on the basis of a test agreement and the resulting test report for each defined serial number range of identically constructed watches.

(b) The manufacturer guarantees that all watches within the serial number range are technically identical to the test objects. Any technical changes within a tested serial number range must be submitted to the testing institute and approved in writing. It may be necessary to conduct supplementary partial verification tests.

(c) The certificate contains the operative temperature range, in compliance with section 3.2.2 (a).

(d) The certificate also includes the provision that its validity with respect to the individual watches in the given serial number range is conditional upon the manufacturer's assurance that each watch placed on the market meets the requirements of the individual tests as defined in sections 3.1.5 (accuracy), 3.1.6 (power reserve) and 3.2.7 (water resistance).

4.2 | Terms and labelling

(a) „TeStaF" and the TeStaF logo are registered trademarks.

(b) Only watches which fulfil the requirements set out in section 4.1 may carry the word „TeStaF" and/or the TeStaF logo on the case and/or the dial and/or in accompanying documents.

(c) Each watch carrying the TeStaF label must be marked with an individual serial number from the tested serial number range.

4.3 | Version number and revisions

(a) The current version of the TeStaF is version 01 (2012).

(b) Information regarding the TeStaF, including the current version of the test agreement and the number of test pieces required, can be obtained from: *www.testaf.org*

(c) Revisions and further development of the TeStaF standard are coordinated by a scientific advisory committee.

(d) Any suggestions regarding the revision or further development of the TeStaF standard will be gratefully received and should be submitted via the contact information provided on the website indicated above.

5 | Appendix

5.1 | Sample TeStaF certificate

[Name of certifying institution]

Technical Standard for Pilot's Watches Certificate

This certificate confirms that the watches listed below have passed the type test in compliance with the Technical Standard for Pilot's Watches (TeStaF) version 01 (2012):

Manufacturer:	.....
Model of watch:	.....
Serial number range:	.....
Strap model designation:	.....

The certification is issued in compliance with section 3.1.1 of the TeStaF for flights using

Visual flight rules	☐
Instrument flight rules	☐

and in compliance with section 3.2.2 of the TeStaF standard

for the temperature range from - .....° C to + ...° C.

The compatibility declaration of the manufacturer and/or supplier indicating compliance with the type test of section 3.2.9 of the TeStaF has been submitted to the testing institute.

The validity of this certificate for the individual watches in the above serial number range is conditional upon the manufacturer's assurance that all watches it places on the market fulfil the requirements of the individual tests (carried out by the manufacturer) in compliance with the following sections of the TeStaF:

3.1.5	Accuracy
3.1.6	Power reserve
3.2.7	Water resistance

This assurance, including the place, date and signature of an authorised staff member of the manufacturer, has been submitted to the testing institute.

Fulfilment of the TeStaF requirements confirms that the watches listed above are suitable for professional use as pilot's watches. For continued use careful observance of the service intervals recommended by the manufacturer, regular checks of the accuracy, power reserve and water resistance are recommended, as are visual and functional inspections.

[Place, date, signature of authorised staff member]

6 | Referenced publications and standards

3. DV LuftBO	*Dritte Durchführungsverordnung zur Betriebsordnung für Luftfahrtgerät (Ausrüstung und Betrieb des Luftfahrtgerätes außerhalb von Luftfahrtunternehmen)* 19 March 2009, issued by Luftfahrt-Bundesamt, Braunschweig. Published in *Bundesanzeiger No. 48*, 27 March 2009
CS-22	*EASA Certification Specifications for Sailplanes and Powered Sailplanes CS-22.* Brussels: European Aviation Safety Agency, November 2003
CS-23	*EASA Certification Specifications for Normal, Utility, Aerobatic and Commuter Catergory Aeroplanes CS-23.* Brussels: European Aviation Safety Agency, November 2003
CS-25	*EASA Certification Specifications for Large Aeroplanes CS-25.* Brussels: European Aviation Safety Agency, October 2003
CS-27	*EASA Certification Specifications for Small Rotorcraft CS-27.* Brussels: European Aviation Safety Agency, November 2003
CS-29	*EASA Certification Specifications for Large Rotorcraft CS-29.* Brussels: European Aviation Safety Agency, November 2003
CS-VLA	*EASA Certification Specifications for Very Light Aeroplanes CS-VLA.* Brussels: European Aviation Safety Agency, November 2003
CS-VLR	*EASA Certification Specifications for Very Light Rotorcraft CS-VLR.* Brussels: European Aviation Safety Agency, November 2003
DIN 8306 / ISO 6425	*DIN 8306 Taucheruhren. Sicherheitstechnische Anforderungen und Prüfung.* Berlin: Deutsches Institut für Normung e.V., September 1983 | Substantially identical to *ISO 6425:1996 Divers' watches*

DIN 8308 / ISO 1413 — *DIN 8308 Stoßsicherheit bei Kleinuhren. Begriff – Anforderungen – Prüfung.* Berlin: Deutsches Institut für Normung e.V., February 1981 | Substantially identical to *ISO 1413:1984 Horology – Shock-resistant watches*

DIN 8309 / ISO 764 — *DIN 8309 Antimagnetische Eigenschaften von Kleinuhren. Begriff – Anforderungen – Prüfung.* Berlin: Deutsches Institut für Normung e.V., February 1981 | Substantially identical to *ISO 764:2002 Horology – Magnetic resistant watches*

DIN 8310 / ISO 2281 — *DIN 8310 Wasserdichtheit von Kleinuhren. Begriff – Anforderungen – Prüfung.* Berlin: Deutsches Institut für Normung e.V., December 1984 | Substantially identical to *ISO 2281:1990 Horology – Water-resistant watches*

DIN 8319 / ISO 3159 — *DIN 8319 Teil 1 Chronometer. Armbandchronometer mit einer Frequenz des Schwingsystems ≤ 1000 Hz. Begriff – Anforderungen – Prüfung.* Berlin: Deutsches Institut für Normung e.V., October 1980 | Substantially identical to *ISO 3159:1976 Timekeeping instruments - Wrist-chronometers with spring balance oscillator*

ED-14F — *EUROCAE ED-14F Environmental Conditions and Test Procedures for Airborne Equipment.* Malakoff (F): The European Organization for Civil Aviation Equipment, March 2008

Esser — Esser, Thomas: *Technischer Standard Fliegeruhren. Belastungen auf Fliegeruhren und deren wichtige Merkmale.* Diploma thesis for Aerospace Engineering degree course at FH Aachen. Aachen: September 2009

EU-OPS 1 — *Commission Regulation (EC) No 8/2008 of 11 December 2007 amending Council Regulation (EEC) No 3922/91 as regards common technical requirements and administrative procedures applicable to commercial transportation by aeroplane.* Issued by the European Commission, Brussels. Published in the *Official Journal of the European Union No. L10*, 12 January 2008

FAR 25.1303 — *Federal Aviation Regulations Part 25 Airworthiness Standards: Transport Category Airplanes, Section 25.1303.* Washington, DC: Department of Transportation [Federal Aviation Administration] (USA), March 1997

FAR 29.1303 — *Federal Aviation Regulations Part 29 Airworthiness Standards: Transport Category Rotorcraft, Section 29.1303.* Washington, DC: Department of Transportation [Federal Aviation Administration] (USA), January 2005

FAR 91.205 — *Federal Aviation Regulations Part 91 General Operating and Flight Rules, Section 91.205.* Washington, DC: Department of Transportation [Federal Aviation Administration] (USA), June 2007

FAR 121.305 — *Federal Aviation Regulations Part 121 Operating Requirements: Domestic, Flag and Supplemental Operations, Section 121.305.* Washington, DC: Department of Transportation [Federal Aviation Administration] (USA), March 1997

ISO 22810 — *Horology – Water-resistant watches.* Geneva: International Organization for Standardization, August 2010

JAR-OPS 1 — *Joint Aviation Requirements JAR-OPS 1 deutsch. Bestimmungen über die gewerbsmäßige Beförderung von Personen und Sachen in Flugzeugen, in the edition dated 1 March 2006.* Issued by Bundesministerium für Verkehr, Bau und Stadtentwicklung, Bonn. Published in Bundesanzeiger No. 131 a, 15 July 2006

JAR-OPS 3 — Joint Aviation Requirements JAR-OPS 3 deutsch. Bestimmungen über die gewerbsmäßige Beförderung von Personen und Sachen in Hubschraubern, 28 January 2008. Issued by Bundesministerium für Verkehr, Bau und Stadtentwicklung, Bonn. Published in Bundesanzeiger No. 64a, 15 April 2008

MIL-PRF-46374G — *Mil-PRF-46374G Performance Specification Watch, Wrist: General Purpose.* Washington, DC: Department of Defense (USA), 12 November 1999 [validated ibid. 19 December 2007]

NIHS 97-21 / ISO 17514 — *NIHS 97-21 Zeitmessinstrumente – Fotolumineszenz-beschichtungen – Prüfmethoden und Anforderungen.* Winterthur: Schweizerische Normen-Vereinigung, June 2006 [amended May 2008] | Substantially identical to *ISO 17514:2004 Time-measuring instruments – Photo-luminescent deposits – Test methods and requirements*

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